PORT-ORFORD-CEDAR MANAGEMENT GUIDELINES

U.S. Department of the Interior
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APPENDICES

I. INTRODUCTION

POC (*Chamaecyparis lawsoniana* [A. Murr.] Pari) (abbreviated hereafter as POC) is a minor but valuable component of the forests of southwester Oregon and northwestern California. It is usually found as scattered individuals in a stand but can also occur in continuous stands. Population distribution inland is usually associated with drainages, particularly in the southern portion of its range (Atzet, 1993). The species occurs primarily at low-to-mid elevations but has been found up to approximately 7,000 feet in northern California (Greenup, 1992a). The greatest concentration of POC is in Oregon in the northern third of its range, on the coastal hills and terraces from Coos Bay to Port Orford and in the adjacent southern edge of the Coast Range, including the drainages on the middle and south forks of the Coquille River (Zobel, 1985). Secondary concentrations occur in land at moderate-to-high elevations near the Oregon/California border and in the watersheds of Grayback Creek and Deer Creek in southeastern Josephine County, Oregon (Atzet, 1979; Hawk, 1977). Throughout its range, the species is under attack by the fatal fungal pathogen *Phytophthora lateralis* (*P. lat.*), which causes POC root disease (Kliejunas, 1981). Forest management activities such as road construction, timber harvest, site preparation, and fuels treatment can increase the risk of spreading the disease by introducing the pathogen to uninfested areas.

POC spans the floristic transition one between the vegetation of California and the Pacific Northwest (Harrow and Harrar, 1969). POC occurs in five plant series in the Klamath Province: white fir (A*bies concolor* Gord. & Glend.), western hemlock (*Tsuga heterophylla* [Raf.] Sarg.), POC, tanoak (*Lithocarpus densiforus* [Hook and Arn.], Rehd.), and Jeffrey pine (*Pinus jeffreyi* Grev. And Balf.) (Atzet and Wheeler, 1984). Tree associates range from Sitka spruce (*Piceal sitchensis* [Bong.] Carr.) in the northern part of the POC range to incense-cedar (*Calocedrus decurrens* [Torr.] Florin) at the lower latitudes. Other common tee species associated with POC include Douglas-fir (*Psuedotsuga menziesi monticola* Dougl.), sugar pine (*Pinus lambertinana* Dougl.), and red alter (*Alnus rubra* Bong.) (Harlow and Harrar, 1969). In addition, the range of POC overlaps an area of high plant diversity containing many other endemic species.

POC is limited to areas with relatively high ratios of precipitation to evaporation (Zobel et al., 1985). POC is opportunistic, and it can establish itself in quantity during early seral stages, after disturbance in stands and under an intact forest canopy. The species is shade tolerant and also grows well in the open. Zobel (1990) found that POC reached breast height in 5 to 11 years in clearcuts; and under a forest canopy, it took 14 to 31 years. Good seed crops can occur as often as every 4 or 5 years but generally not for 2 years in a row (Zobel, 1979).

II. ***PHYTOPHTHORA LATERALIS*** **AND PORT-ORFORD-CEDAR**

The first external evidence of the root disease is a slight discoloration of the foliage which, within a few weeks to months, depending on the weather conditions and tree size, gradually takes on a yellow wilted appearance. The color changes from yellow to bright red, then to red-brown, and finally brown. Trees usually lose all foliage 2 to 3 years after death. POC root disease is best identified by the cinnamon-colored inner bark and cambium that abruptly joins the creamy white, healthy inner bark in roots and lower boles. Just prior to tree death, the discolored zone may extend 2 to 5 feet above ground (Hadfield et al., 1986).

An infection of *P. lat.*, possible and introduced pathogen, was first reported in an ornamental POC near Seattle, Washington, in 1923. It was fond in southwestern Oregon in 1952 (Roth et al., 1987). There is no proven resistance to *P. lat.* with POC although occasional POC remain alive after surrounding POC have been killed (Hansen et al., 1989). Whether this survival is due to some degree of resistance or lack of exposure of the pathogen remains unclear.

P. lat. is a root-inhabiting fungus transmitted via soil and/or water. The pathogen enters through root grafts or directly through the tips of fine roots (Gordon and Roth, 1976). Damage from this moisture- and low-temperature-dependent fungus peaks during the cool, wet season; but crown symptoms lag behind due to abundant atmospheric moisture. As moisture stress builds in late spring and summer, the damaged root system is unable to meet the evapotranspiration requirements of the tree. This results in the simultaneous death of the crown (Zobel et al., 1985). While seedlings and small POC quickly succumb to the pathogen, large POC may take a year or more to die.

The resting spores (chlamydospores) develop in rootlets and are released into soil as the roots deteriorate. The dormant chlamydospores form fruiting bodies (sporangial) in saturated soil, which in turn release motile zoospores. Zoospores required flowing water to travel any distance. The fungus survives as chlamydospores in soil without a host for up to 4 years in northwestern California (Kliejunas, 1992). Spore survival, without a host, in the Coos County forest and at Oregon State University has reached 6 years and 7 years, respectively. At both sites, chlamydospore population levels are on a downward trajectory (Hansen, 1994).

Chlamydospore survival rates decline during periods of summer drought, which is a normal occurrence in portions of the range of POC. A significant decrease in spore survival occurred when isolated organic matter, and organic matter in soil containing *P. lat.* spores, was stored in sealed plastic bags and heated to 68 degrees Fahrenheit for a period of 18 weeks. At this same temperature, survival of *P. lat.* inorganic matter was favored in moist soil, but not in saturated soil. Naturally infested organic matter in clay soil stored in sealed plastic bags did not show a decreased survival in moist soil (0.3 bars tension), but did show decreased survival in saturated soil (0 bars tension). In slightly dried soils (approximately 25 bars tension), *P. lat.* survived at only very low levels after 16 weeks at 68 degrees Fahrenheit (Ostrofsky et al., 1977).

Spore transport occurs via a variety of mechanisms. Logging equipment, vehicles, humans, and animals (particularly elk) can transport infested soil (Zobel et al., 1985). It can be transmitted by surface water in streams or ditches. Disease transmission can also occur via root grafts and, in some rare instances, through rain splashed spores (Gordon, 1974). Trees in close proximity to the stream channel downstream from infected areas have the best chance of contracting the disease. Upslope spread is more difficult, occurring through root grafts and possibly by disease movement from infected to uninfected POC roots that are in close proximity to each other (Gordon, 1974).

If soil infested with chlamydospores is transported to uninfested areas, new infections can occur. This requires a precise sequence of events: chlamydospores must reach POC root tips; germination must occur; and the root tips must be penetrated to initiate infection. *P. lat.*, while fatal to POC, may not be the sole cause of death in a given tree. Microsite conditions such as moisture stress, mechanical damage, or insects can contribute to mortality.

Once a tree becomes infected, mortality is frequently rapid. However, when infestation occurs in an area, it is rare for all of the POC to become infected. Surveys done in areas where the pathogen has been present for 30 years have shown that not all POC were killed (Schoeppach, 1991). Whether this phenomenon is due to resistance, isolation, unknown factors, or a combination of these, is not clear.

III. *PHYTOPHTHORA LATERALIS* AND PACIFIC YEW

Recently, it has been documented that Pacific yew (*Taxus brevifolia* Nutt.) is also susceptible to *P. lat.* (DeNitto and Kliejunas, 1991; Greenup, 1992). Pacific yew contains taxol, a compound which has shown promise as an ovarian cancer treatment. The Pacific yew mortality only occurred in areas where there are also infected POC. No mortality due to *P. lat.* has been documented on BLM lands.

Pacific yew infected with *P. lat.* show the same symptoms as those seen on infected POC. Crown discoloration and cambium stain occur. It appears that the resistance to *P. lat.* within Pacific yew is more variable than that seen in POC (Greenup, 1992a).

IV. MANAGEMENT OBJECTIVES FOR PORT-ORFORD-CEDAR

POC requires special protection because it is an important component of some forest ecosystems, it is economically valuable, and it is vulnerable to an introduced pathogen that is spread primarily through human activities.

A. Proactive management – limit the spread of *P. lat.* and reduce the number of infested areas.

B. Retain POC as a species, identify resistant individuals, and incorporate them into a tree improvement program.

C. Incorporate *P. lat.* control strategies as management objectives in Riparian Reserves (RRs), Late-Successional Reserves (LSRs), and Matrix.

D. Provide POC as a primary forest product.

E. Promote public involvement in POC management.

F. Develop a budget and implementation schedule for the Port-Orford-Cedar Management Program.

V. IMPLEMENTATION STRATEGY TO ACHIEVE POC MANAGEMENT OBJECTIVES

A. Proactive management – limit the spread of *P. lat.* and reduce the number of infected areas.

The intent is to stop the spread of *P. lat.* into POC and Pacific yew populations, and to design and implement management strategies that decrease the number of disease locations in a manner consistent with objectives identified in district resource management plans. At present, no documentation exists that indicates a successful eradication of *P. lat.*, on a specific site has been accomplished. A management strategy for an area may include POC eradication and preventing POC regeneration until the inoculum present on the site dies out. The ultimate goal is to reestablish POC into those areas where the pathogen had previously existed.

An accurate inventory of POC and *P. lat.* is essential for the development of a management strategy. Populations of POC should initially be mapped geographically by plant series and associations. Areas where POC is found should then be subdivided according to seed zones and elevation bands. Areas where timber harvest has occurred that still contain POC populations must be examined for the occurrence of *P. lat.* Areas with POC present, and where no harvest activities have occurred, should receive the same analysis.

The inventory of POC and *P. lat.* areas will be ongoing as the POC management strategy is implemented. At a minimum the inventory should include the following:

1. Determine which POC areas also have populations of Pacific yew.

2. Track all occurrence of POC populations and *P. lat.* infestations in MICRO*STORMS (M*S) and Geographic Information Systems (GIS).

3. Analyze the relationships between infested and uninfested areas (i.e., what is the probability of the uninfested stand becoming infested?) Further analysis should examine if *P. lat.* infested sites are expanding, stable, or decreasing, the relationship of *P. lat.* population trends to land management activities, and the specific reasons for the impacts to *P. lat.* populations.

4. Monitor for occurrence of *P. lat.* and the effectiveness of management of the pathogen and disease control. Monitoring projects will need to continue for at least 5 years in the drier portions of the range of POC and for longer periods where climatic conditions are wetter.

This information should be consolidated in an annual report.

All entries into POC areas should be coordinated with the district POC program lead and the resource area silviculture group(s). The forest development program should incorporate POC objectives in reforestation, timber stand improvement, and the development of silvicultural prescriptions. Strategies to meet road construction, renovation, maintenance, and road management objectives need to include POC goals. Existing timber sales that do not address POC should be modified to include consideration for POC management. Entries are not just those for timber sales or silvicultural activities. They include, but are not limited to, such things as firewood cutting, hunting, and any other actions within POC areas.

There are at least three key risk indicators regarding the introduction of *P. lat.* to uninfested sites. The first is the potential for infested soil to be transported upstream of uninfested POC areas due to an increase in exposure points such as steam crossing or roadwork (new construction, renovation, maintenance, or decommissioning). Recreational activities such as horseback riding, off-road vehicle traffic, or even mountain bike riding could also increase the chances of *P. lat.* infection. The second factor Is the duration of the increased risk; that is, the number of trips by logging trucks, logging machinery, etc. The more trips, the greater the potential for infection. The third risk indicator is the season in which activities occur in POC areas. Activities that occur during the wet season have a greater potential to move infested soil to areas that presently do not contain *P. lat*. A risk analysis procedure has been developed by the USFS and is presented as Appendix 4 is this paper. This appraisal should be conducted for all areas containing POC.

POC, *P. lat.*, and Pacific yew mapping will be the key to success of the Interregional POC Coordinating Group, of which BLM is an active participant. This group was established in 1987 to ensure a coordinated, interregional, interagency effort to manage the root disease. The group structure has recently been reorganized into two areas: a policy oversight team and a technical team. The policy oversight team will include a representative from: (1) Forest Pest Management in USFS Region 5, (2) Forest Insects and Diseases Group in Region 6, (3) the Forest Supervisors, and (4) the Oregon/Washington State Office and Medford District Office of the BLM.

B. Retain POC as a species, identify resistant individuals, and incorporate them into a tree improvement program.

The goal is to join with the USFS in its research program to identify genetic resistance to *P. lat*. Resistance is defined as slowing the rate of a pathogen's advance in diseased tissue, rather than immunity. No trees have been identified that have the potential to stand up indefinitely in areas of extreme inoculum exposure. However, though a breeding program, the possibility of producing stock with a high level of resistance certainly may exist (Martinson, 1994). As with Douglas-fir, POC has a wide tolerance for variations in environment (probably related to genetic variability) that allows it to compete successfully in a wide range of environmental conditions (Millar et al., 1991). This great ecological amplitude of POC is believed to reflect a geographic concentration of genetically-based characteristics that had developed in a much larger geographic range (Edwards, 1983).

In the past, ornamental varieties of POC have been grafted to root stocks of *P. lat.*-resistant members of the family Cupressaceae with varied success (Torgeson et al., 1954). Research continues regarding POC and *P. lat*. Currently, the Pacific Southwest Research Station is conducting a rangewide genetics study on POC. Under contract with the USFS, researchers at Oregon State University are evaluating the survival of potentially resistant parent trees, collecting seed and vegetative material from parent trees for propagation, and screening seedlings and rooted cuttings for resistance (Greenup, 1992b). With the exception of the Coos Bay District, BLM has not been actively involved with these programs in the past. However, there are opportunities to support upcoming studies on POC. Specific actions include, but are not limited to, identification of resistant POC, cone collections from suspected resistant individual trees, and outplanting of seedlings grown from collected seed to test resistance. These research opportunities should be anticipated and aggressively pursued. Management objectives and practices will need to be reviewed and updated as additional research is published.

Current searches for resistance are in highly-infested areas where selection pressure has been present for some time. Single trees that have survived in areas of sever mortality may be resistant. Harvesting or precommercial thinning of POC in infected areas should be preceded by evaluation of the POC population for resistance. All trees should not be tested, as this is biologically unnecessary as well as financially impractical. Even the most ambitions sampling schemes cannot test all trees within a given population. The probability of removing a tree with some level of resistance is extremely low in areas that have not seen extensive mortality (Greenup, 1992a).

The current screening process for POC with resistance has been underway for over 10 years. The screening criteria was developed by Dr. Lewis Roth and Dr. Everett Hansen of Oregon State University, Don Goheen of the Southwest Oregon Forest Insect and Disease Technical Center et al. Screening includes POC stem inoculation with *P. lat.*, soil inoculation with *P. lat.* and transplanting POC into the infested soil, and immersing the root of seedlings and rooted cuttings in a water suspension of *P. lat.* zoospores (Hansen et al., 1989). Over 200 selected trees are currently being evaluated for resistance. Discussions with USFS geneticists and pathologists indicate an extremely low potential for loss of resistance by harvesting or other removal of POC (Greenup, 1992a). Timber sales involving green POC should be evaluated for resistance candidates prior to harvesting.

<u>Guidelines for selecting trees in the wild for resistance:</u>

1. Select trees that appear to have been exposed to the fungus. Selected trees should retain green crowns and be in close proximity to those exhibiting symptoms of *P. lat*.

2. Select trees in previously infested areas that stay wet for long periods of time.

3. Selected trees that are not elevated on rises above existing infected trees. Roots should be wet or have been subjected to the same water flow as infected trees.

4. The candidate tree should have root disease killed trees above and below it on the same slope.

5. Trees should have normal-looking green foliage and should have been exposed at the time the existing dead trees were exposed.

6. POC roots graft with roots of other POC. In wet areas, the pathogen will involve the entire area.

7. Trees occurring on the edges of visibly infested sites can be selected for resistance testing if they meet the probably exposure criteria (Greenup, 1992a).

Some POC populations occur on lands set aside for uses other than timber production. It will be necessary to ascertain which seed zones and elevation bands containing uninfected POC colonies are not represented in the set aside areas. Additional uninfected POC populations may need to be reserved for maintenance of POC gene pool diversity. Populations that are reserved should be selected by plant series and associations. POC genetic diversity appears to increase with decreasing elevation and soil diversity (Millar and Marshall, 1991). In general, BLM lands are lower in elevation than those administered by the USFS. Therefore, POC populations on BLM lands may have a greater genetic diversity that that currently known to exist.

C. Incorporate *P. lat.* control strategies as management objectives in RRs, LSRs, and in the Matrix.

There are some specific situations involving POC management that deserve distinct consideration: management actions in infested RRs, LSRs, within the Matrix, or other special management areas that contain *P. lat.* or uninfected POC. These areas will require application of site-specific procedures. With careful consideration, an integrated strategy can be developed where more than one resource value can be enhanced. Any action(s) taken must be consistent with the management objectives identified in the district RMO for these areas.

1. Riparian Reserves

Riparian areas may contain diseased POC. In some areas, it may be possible to remove POC while at the same time maintaining riparian quality. To realize the full benefits for the riparian management area, consult with the wildlife biologist, fisheries biologists, hydrologists, and other resource specialists to identify the specific objectives for that riparian area, and how POC management can assist in attaining these goals. POC management within RRs must conform to the Aquatic Conservation Strategy (USDA and USDI, 1994).

Live trees showing signs of infection, but needed to increase the dead wood component in riparian areas, could be girdled and left to fall or felled intentionally if additional down woody material is required immediately. The presence of snags and logs in most environments make them particularly valuable to amphibians (Oliver, 1992). One contribution from POC management that could provide immediate and future benefits is the status of the coarse woody material component of the riparian area. Determine whether the riparian area's present and predicted future requirements for large woody material are being and will continue to be met. If additional material is required, specialists can use geometric and empirical equations based on tree size and distance from the stream to identify POC that can provide large woody material recruitment (Robinson and Beschta, 1990). Because of their resistance to decay, POC snags and logs are long-lived components of riparian habitat (Jimerson and Creasy, 1991).

Riparian area containing dead or diseased POC must be surveyed to determine whether an adequate amount of snags and down logs exist. Girdled trees would create snags and future sources of coarse woody debris. If existing levels of down wood are less than desired, POC could be felled; either to provide down logs outside the stream or to crate an in-channel structure. POC logs also provide organic input as well as structure to streams where anadromous fish spawn.

Preliminary work has been done in determining these figures. USFS data for both the POC and Tanoak series give some indications of the snag component for these forest communities where little human disturbance has occurred (Atzet and McCrimmon, 1992). Unfortunately, data for down coarse woody material has yet to be developed; but the case can be made that is the natural snag component is maintained over time, coarse woody debris requirements will also be maintained. Snags and other woody debris need not, and should not, be recruited solely from POC; but dead POC does present an opportunity to provide a habitat component that may be lacking.

Since the disease can move via root grafts, monitoring would be required to determine if root contact between uninfested POC and the infection center has been broken. There is little information available regarding the development of POC root systems. The only detailed description of POC root systems is for a 50-year-old dense stand in coastal Coos County. In this stand, 0.6 percent of the major roots extended beyond 6.7 meters from the bole of the tree (Gordon, 1974; Gordon and Roth, 1976). Based on this work, treating an area infected with *P. lat.* could include green POC adjacent to the infection site and currently showing no sign of *P. lat*. This could involve the removal of the live host (green trees that show no sign of infection) adjacent to the infection site. Again, removal could involve girdling, cutting and leaving the tree, or even harvesting the green POC. Elimination of live POC adjacent to infection sites would further reduce the potential for *P. lat.* propagation. This strategy has been implemented on the Gold Beach Ranger District, Siskiyou National Forest (Gee, 1993). In this case, all POC within a distance equivalent to five times the crown radius of the infected tree(s) have been removed.

There will often be portions of the RR infested with *P. lat.* that have POC too small to be girdled. One management approach could be to girdle POC greater than six inches dbh, slash smaller POC (down to 1 inch in diameter at 1 foot), and use prescribed fire to kill POC that are too small to slash. The prescribed fire treatment utilized could be a broadcast burn, underburn, swamper burn, or whatever application of fire best fits the objectives for the riparian management area. Of course, this would only be applicable where prescribed fire is consistent with RR objectives. Due to the sensitivity surrounding the use of herbicides, it is recommended that they not be utilized in removing POC.

No commodity extraction of POC should occur prior to a watershed analysis. After a watershed analysis is complete commodity extraction could occur if it is consistent with objectives identified in the watershed analysis.

2. Late-Successional Reserves

A second area of concern are areas containing *P. lat.* that are within LSRs. Management objectives for LSRs are to protect and enhance conditions of late-successional and old-growth forest ecosystems which serve as habitat for late-successional and old-growth-elated species, including the northern spotted owl (USDA-USDI, 1994). In those areas where POC provides a significant portion of the forest canopy, *P. lat.* could, over time, contribute to canopy loss and be detrimental to maintaining quality LSR habitat. Treating the pockets of *P. lat.* that occur within LSRs will have some short-term impact on canopy cover and species diversity; but by isolating or eliminating the diseased area or areas, POC may be retained inside the LSRs and contribute to overall species diversity.

As stated above under RRs, considerations for snags, down woody material, and their associated resource values are necessary in LSRs. Consultation with wildlife biologists and other resource specialists will determine management opportunities. Creative management can reduce *P. lat.*, enhance the amount of snags and down woody material, ensure snag and down woody material recruitment, and perhaps even provide some timber volume for commodity production.

The intent is to isolate *P. lat.*-infested areas and to reduce the potential for spread of the pathogen via root grafts. This could be accomplished by removing green POC from around the periphery of disease centers. This would accomplish two objectives. POC populations would be separated into populations of infected and uninfected POC, and the possibility of locating resistant POC within the infested areas would be retained. The possibility exists that girdled POC or severed POC stumps may remain alive due to root grafting. However, it has been shown that most roots not directly involved with root grafts die (Bornamm, 1966). Therefore, even if the severed or girdled POC stumps remain alive, benefit can be achieved by reducing the receptive sites for *P. lat.* (Gordon, 1974).

The emphasis in LSRs is not on timber as a commodity. It is recommended that POC harvest or salvage occur only after realizing other resource objectives which might benefit from large woody material input from POC. Snags can serve a variety of purposes for wildlife including, but not limited to, nesting platforms, feeding substrates, and roosting sites. While the decay rate of POC snags is not clear, a related species, western red cedar, has been shown to be the most persistent snag in forests of Coast Range (Cline, 1977). While this may provide for long-term utilization of POC snags for the uses previously mentioned, slow decay rates may reduce the opportunity for cavity nesters to occupy POC snags. Wildlife use of POC snags appears not as high as that of pines or Douglas-fir, but this is likely partially offset by the longevity or the snags (Jimerson, 1989). The level of large woody material input from POC will have to be determined through an interdisciplinary analysis and occur on a site-specific basis.

Preliminary data from USFS ecology plots in the POC series shows that while stands have the potential to become dominated by POC, there are generally other conifers and hardwoods present that contribute to stand structure and canopy closure (Atzet and McCrimmon, 1992). Data combined from all the plots in the POC series indicated that POC is normally not the dominant tree in those stands. If this situation exists, then removal of the live host of *P. lat.* may be possible without significant loss of canopy cover in the POC series that occur in spotted owl habitat.

3. Matrix

Most timber harvest and other silvicultural activities will be conducted in that portion of the Matrix with suitable forest lands (USDA-USDI, 1994). Stands in the Matrix can be managed for timber and other commodity production, but they also have an important role in maintaining biodiversity. Silvicultural systems for stands in the Matrix should provide for the retention of old-growth ecosystem components such as large trees, snags and down logs, and depending on site and forest type, a diversity of species (Thomas et al., 1993). Green tree retention is a significant component in the management of Matrix lands. Green trees can be retained, both as individuals and in well-distributed patches. Patches of green trees of various sized, ages, and specie swill promote species diversity and may act as refugia or centers of dispersal for many organisms including plants, fungi, lichens, small vertebrates, and arthropods (Esseen et al., 1992). Patches of green trees may also provide protection for special microsites such as seeps, wetlands, and rocky outcrops.

POC should be treated the same as any other commercial species in the Matrix. Special considerations for this species are identified later in the document (see following Mitigating Measures for Timber Sale and Service Contractors). Rather than girdling and leaving POC as mentioned above in the RRs and LSRs, merchantable POC can be removed for commodity production. It is recommended that areas of *P. lat.* be targeted for POC harvest. Residual uninfected POC can be left as part of the green tree retention previously described. Slashing of small POC and prescribed fire may be used to eliminate unmerchantable POC from infested areas. This removal of the host species could reduce the presence of *P. lat.*; and if POC is eliminated from a diseased site for more than 5 years, there is the potential for *P. lat.* to die out. This 5-year-time-period is for the drier portions of the POC range. More mesic sites, such as those found in the Coos Bay District, will require a longer period of POC absence in order for *P. lat.* to die out.

Monitoring will be essential to track the existence of *P. lat*. One potential monitoring technique is to plant small quantities of POC in areas suspected of still being infested. This could be done as a cluster plant with other species not susceptible to *P. lat*. If the disease is still present, mortality in the POC would show up quickly and could be documented in stocking surveys at the end of the first growing season. If no POC mortality occurs, the excess conifers resulting from the cluster plant could be removed (Viets, 1993).

D. Provide POC as a primary forest product.

POC can be exported as whole logs from Federal lands. A species can be exported if it can be shown that domestic use of the timber is absent or minimal (Land, 1992). Hinoki *(Chamaecyparis obtusa)* is used in the construction of homes and temples in Japan. Due to decreasing populations of hinoki, the demand for POC has increased. Five dollars per board foot or $5,000 per thousand have been paid for POC (Brattain and Stuntzer, 1994).

Matrix lands infested with *P. lat.* should be targeted for salvage operations as soon as possible. Reserves should be considered for salvage only after the appropriate analysis has been completed (watershed analysis for RRs or management plan for LSRs). It is recommended that mortality salvage operations occur within 3 years of the death of any POC in the Matrix, and as soon as possible in other areas as long as the salvage is consistent with management objectives. The export value of POC was reduced after 3 years due to a decrease in grade (Zobel et al., 1985). This contrasts with POC killed by fire. Fire-killed trees can retain their merchantability for a longer period of time due to exterior charring. In addition to salvage, green POC should be removed from around the infested area to reduce the possibility of disease transmission via root grafts. The distance for removal of POC would have to be determined on a site-by-site basis.

Areas not infested by *P. lat.* need not be off limits to timber harvest. However, steps must be taken to reduce the probability of initial infection. Mitigating measures for timber sale and service contracts are listed in Section

VI below. It is anticipated that a helicopter would frequently be the logging system of choice, but conventional systems could also be used when they are consistent with management objectives for the area.

E Public Involvement

Public education and media involvement should be incorporated into our guidelines. Groups such as the Oregon Natural Resource Council, the Western Environmental Law Center, Inc., the Siskiyou Regional Education Project, the Nature Conservancy, and the Sierra Club have indicated interest in POC management. Involvement and coordination with private landowners and other neighbors will provide better awareness of *P. lat.* problems, reduce the potential for new *P. lat.* infections, and help organize the management of POC and *P. lat.* across ownerships. Upon adoption of a rangewide POC management plan, a news release could be issued to the media. There has already been interest shown by members of the press as the information regarding Pacific yew susceptibility to *P. lat.* has become more widely known. Educational signs identifying road closures for POC and *P. lat.* management should be posted in all areas containing POC. Lectures to interested groups could also enhance the image of the BLM POC management program. A brochure similar to the USFS pamphlet, Port-Orford-Cedar Root Disease (FPM Report #294), should also be developed by BLM.

F. Develop a budget and implementation schedule for the POC Program.

POC areas should be mapped, and lists of the Operations Inventory Units containing POC should be developed. The next step is to develop lists of infested and uninfested areas containing POC.

Without an accurate inventory of POC and *P. lat.* occurrence, successful management of POC and *P. lat.* has little chance of success. The suggested procedure is as follows:

Inventory	General survey for POC and *P. lat*. Determine if POC is present and if *P. lat.* is present. Determine the extent of the POC and *P. lat.* (Are all POC infected?). Map areas with and without *P. lat*. M*S and GIS: Input data into MICRO*STORMS and GIS. Develop GIS maps of POC and *P. lat.* areas and input recommended treatments into M*S database.
Implementation Plan Development	Develop strategies for POC management inside Riparian Reserves, Late-Successional Reserves, Matrix, and other management areas.
Plan Monitoring, Ongoing Adaptive Management, and Modification	

Future needs will focus on developing site-specific management plans for all areas containing POC, and monitoring POC areas to see if the disease has been isolated or eliminated from infected areas and prevented from spreading into disease-free areas.

IV. MITIGATING MEASURES FOR TIMBER SALE AND SERVICE CONTRACTS

It appears that when areas of POC and *P. lat.* are accurately mapped and mitigation measures are implemented, the successful spread and establishment of the disease into new watersheds is a rare event. The use of effective mitigation measures, combined with a low risk of establishment following the spread of the disease, has prevented the spread of the disease into uninfested watersheds in California (Kliejunas, 1991).

A. Restrict road building and log hauling to the dry season unless the contract calls for cleaning the vehicles to prevent import or export of the root disease. This will lessen the chance of infested soil adhering to equipment and vehicles and consequently from being transported to uninfested areas.

B. Road design: When feasible, outslope the roads or use crushed rock to keep the soil in place. A slight outslope is best as the soil landing on the fill slope has a low probability of ending up in streams. Insloped roads will cause soil to end up in the ditch and eventually enter into streams, placing downstream POC populations in jeopardy. Culvert and waterbar placement should also divert water from areas where POC exists.

C. In POC areas, do not allow blading into road ditches upstream from the uninfested areas. Blade to the fill slope only. Do not allow sidecasting where sidecast material could reach the stream channel.

D. Wash with chlorine bleach and water or require steam cleaning or high pressure water treatment for all machinery and vehicles prior to entry into the uninfested project areas. Require the same washing and cleaning for machinery and vehicles prior to departure from infested sites. The ration of chlorine bleach and water for vehicle washing is 12 ounces of bleach per 1,000 gallons or water. Charge the vehicle cleaning to the timber sale or whatever activity requires entry into the POC area. See Appendix 2 for additional information.

E. Gate or barricade roads in areas containing POC, both uninfested and infested, when consistent with other resource objectives. This prevents vehicle introduction of *P. lat.* into uninfested areas and the transport of *P. lat.* out of infested areas. Lack of access also reduces the potential for theft and can be incorporated into the resource area road closure policy designed to benefit resources other than timber such as terrestrial wildlife, fisheries, and other values identified as part of the Aquatic Conservation Strategy.

F. In timber sales containing infested and uninfested areas, harvest uninfested areas first so that the equipment does not become contaminated and the contamination moved to uninfested areas.

G. Use chlorine bleach and water or steam cleaning to wash chokers and equipment if a helicopter yarding system is used.

H. Have an interdisciplinary team review and make recommendations to the area manager on all activities in POC areas. Fisheries projects, riparian enhancement, and recreation site development are examples of undertakings that should have interdisciplinary team review.

I. Remove the belly plate from all tractors that have worked in infested areas, and steam clean or wash the tractors with chlorine bleach and water prior to leaving the site. In uninfested areas, steam clean or wash all skidding, yarding, and hauling equipment prior to entering the site. See Appendix 3 for specific vehicle parts that may require cleaning.

J. Do not allow POC bough cutting until the following steps are completed:

1. Inventory for POC and *P. lat.*

2. Determine if bough cutting is consistent with management objectives for the area.
3. Only allow bough cutting in small areas where administration and law enforcement have easy access.

K. Develop monitoring plans for all POC areas. This could include such things as checking contract diaries for rainfall events during logging and activities outside of the scope of the contract.

L. Coordinate with the USFS, state and county forestry departments, private groups, and individuals that have an interest in POC management.

M. Require roadside brushing: (all distances are slope distances)

1. Upslope: Cut all POC within 20 feet of the road edge; if cut slopes are greater than 5 feet in height, remove POC only between the road edge and the top of the cut slope.

2. Downslope: All POC within 50 feet of the road edge, downslope from the stream crossing, and all POC that have roots within the stream channel should be killed where the stream channel intersects the road right-of-way.

These disturbances are used as examples and can be modified to fit a particular situation. In addition, this is not mandatory and should only be used when there is a high likelihood of importing *P. lat.* into a project area where other mitigating measures have low potential for success.

N. Reforestation: Plant POC at 25-foot spacing or in approximately 1-tree clusters at 100 to 150 foot spacing. This does not apply to planting mentioned above where presence of *P. lat.* is being determined.

O. Precommercial thinning: Allow for adequate spacing between POC in precommercial thinning contracts. This will lessen the chance of root grafting and potential pathogen transmission. Use 25 feet as a spacing guideline in precommercial thinning.

P. Commercial thinning: Allow for adequate spacing between POC in commercial thinning contracts. Use 50 feet as a spacing guideline in commercial thinning sales. This will lessen the chance of root grafting and potential pathogen transmission.

Q. Thinning can also be designed so that POC is left in tight clusters 100 to 150 feet apart. The intent is to minimize the potential for root grafting between clusters of POC.

R. Endhauling/slide removal: Prior to removing soil and other material, determine is either the source of the destination of the material is infested with *P. lat.*

APPENDIX 1

SYNOPSIS OF REGIONS 5 AND 6 PORT-ORFORD-CEDAR COORDINATING GROUP ACTION PLAN

A. INVENTORY AND MONITORING

Goal: Develop a standard inventory and monitoring system for regional use.

Action items/objectives:

1. Inventory to establish POC locations.

2. Inventory to establish current boundaries of infection.

3. Monitor to establish the rate of spread, locally and species-wide.

4. Evaluate the effects of mitigating measures.

B. RESEARCH AND ADMINISTRATIVE STUDY

Goal: Develop a coordinated and prioritized approach to administrative studies and encourage research by other parties that is responsive to the management of POC.

Action items/objectives:

1. Test strategies of control for efficacy.

2. Encourage research units to initiate studies on identified research needs in the following priority:

a. Develop methods to detect the pathogen in soil and water.

b. Determine the requirements of the pathogen for survival and dispersal.

c. Study measures to eliminate the fungus from areas of incipient infection.

d. Investigate the existence of resistance to the pathogen within the range of POC.

e. Determine to what extent genetic variation exists in POC.

C. PUBLIC INVOLVEMENT AND EDUCATION

Goals: Develop a coordinated regional effort to keep the public informed of the progress of POC management and incorporate public involvement in the process.

Action items/objectives:

1. Keep interested groups up-to-date on the progress of POC management.

2. Provide opportunities for interested groups and individuals to contribute to the coordinating team.

D. MANAGEMENT

Goals: Develop an agreed-upon and coordinated program to manage POC in the presence of root disease and generate criteria and mechanisms to determine the risk of spread.

Action items/objectives:

1. Continue to refine and update the risk assessment model used in evaluating projects.

2. Develop strategies for the management of the following activities:

   a. Timber sales

   b. Road construction and management

   c. Reforestation and stand management

   d. Other activities that have potential for earth-moving activities (such as quarry development) in stands containing POC.

3. Develop a system or method for sharing information.

APPENDIX 2

GENERAL SPECIFICATIONS FOR A WASHING STATION

Purpose: The purpose of the washing station is to remove as much soil and organic matter from vehicles as possible to prevent the spread of *P. lat*. Vehicles and equipment should be sanitized prior to entering uninfested areas and prior to departure from infested areas. The intent is to reduce the spread of *P. lat.* into uninfested areas. Sanitation can be accomplished with a mixture of chlorine bleach and water or by steam cleaning. The ration of chlorine bleach to water is 12 ounces of bleach per 1,000 gallons of wash water.

When locating and constructing a washing station to clean vehicles and equipment, we need to minimize the chance that a "clean" truck will be re-exposed to infested material near the washing site. There are two ways this can happen. One is if the truck travels through an area where "unclean" trucks are also traveling. This can be minimized by proper location of the washing station. If some common travel ways are used, efforts need to be made that will reduce the chance of picking up soil. This can be accomplished by rocking the common road surface or hardening it in some other fashion. Reducing the amount of water used for dust abatement will lessen the amount of mud which may also prove useful.

The second way a "clean" truck could become a carrier again is by traveling through wash water and mud at the washing station. Proper construction of the site will eliminate this risk. Runoff of the wash water needs to drain away from the wash site and away from the travel route to and from the site. Wash water must not be allowed to drain into stream channels. The actual washing site needs to be elevated so that the trucks are not sitting in mud and wash water. This could be accomplished by ramps or by building a sufficiently high rocked surface on which the trucks can travel. The length of the rocked surface wash area should be at least 1.5 times the length of the trucks that will be using it. This will allow the trucks to travel on a non-contaminated surface for a short distance after being washed and reduce the chances of picking up infested soil from the washing. The gravel used for rocking should be of sufficient size to allow good percolation of water and soil into the subsurface. Accumulations of water and soil on the surface should be avoided. This last point also affects the depth of the rocked road surface. The amount of washing and the number of trucks using the site will also influence the depth.

The type of equipment used for washing needs to be sufficient to remove all soil and organic matter that is clinging to the trucks. The actual water pressure required can best be determined on the site. Each time a truck enters an uninfested site, it needs to be washed.

APPENDIX 3

EQUIPMENT CLEANING CHECKLIST

The purpose of this checklist is to provide guidance to contract administrators in the enforcement of equipment cleaning contract provisions for *P. lat.* control. This is a guide to direct administrators to specific areas on equipment that are likely to accumulate soil and should be check. Onsite judgments still need to be made about overall equipment cleanliness. This will be a new procedure for many purchasers and they need to be convinced of the seriousness of the situation prior to beginning the contract. Effective enforcement procedures (such as shutdowns) must be available to the contract administrator.

Does the equipment appear to have been cleaned?

Is the equipment clean of clumps of soil and organic matter?

RUBBER-TIRES VEHICLES	**TRACK-LAYING VEHICLES**
Tires Wheel Rims (underside and outside) Axles Fenders	Tracks Road Wheels Drive Gears Sprockets Roller Frame Track Rollers/Idlers
ALL VEHICLES AS APPROPRIATE Frame or Undercarriage Belly Pan (inside) Stabilizers (jack pads) Grapple and Arms Dozer Blade or Bucket and Arms Ripper Brush Rake Winch Shear Head Log Loader Water Tenders (empty or with treated water)	

APPENDIX 4

PROJECT ANALYSIS AND IMPLEMENTATION

(from the USFS POC Action Plan)

Threshold of Concern:

% of POC	RISK		
	Low	Medium	High
Low 0 to 5%	No concern	No concern	High concern
Moderate 5 to 20%	No concern	High concern	High concern
High >20%	High concern	High concern	High concern

Defining Risk:

Low	Below roads: No POC within 500 feet. Above roads: No POC within 50 feet.
Moderate	Below roads: POC may be within 100-500 feet of the road. Above roads: No POC within 50 feet.
High	Below roads: POC within 100 feet. Above roads: POC within 50 feet.

Objective A: Prevent the import of disease into uninfected areas.

Objective B. Prevent the export of disease to uninfected areas.

Objective C: Minimize increases in the level of inoculum or minimize the rate of spread in areas where the disease is endemic. If possible, identify the probable mechanism of spread; whether by introduction of spores or by root grafting.

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